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L.—*Development of the Marine Sponges from the earliest recognizable Appearance of the Ovum to the Perfected Individual.* By H. J. Carter, F.R.S. &c.

[Concluded from p. 337.]

Development of the Embryo of the Calcareous Sponges.

For this purpose I must confine myself entirely to *Grantia compressa*, which, growing much above low-water mark and chiefly on the branches of the little delicate seaweed *Ptilota sericea* as it festoons the ledges of the overhanging rocks, exists in a most convenient position for examination, inasmuch as, by cutting off the branch of *Ptilota*, we can reduce the foreign object on which the sponge grows to a very minute size without interfering with the sponge itself; added to which, the bent club-shaped form of its surface-spicule (Plate XX. fig. 20) is so peculiar that, even in the minutest forms, the species can be determined by its presence.

The walls of this little purse-shaped sponge are, in the months of March, April, and May, charged with the embryos of the species, as well as ova, from their earliest recognizable form up to the matured state of the embryo just before its exit. Here I might observe that in the months of June and July, after the embryos have been issuing from this sponge for some time in great abundance, they may be found fully developed and in groups of all sizes on the branches of the *Ptilota*, immediately around the parent, where, although the largest have a branched tubular form very different from the compressed one of the parent, yet their position in proximity to the adult, together with the presence of the club-shaped surface-spicule (Pl. XX. fig. 20), at once identifies them as belonging to it. And it seems worth remarking that while the cavity of the parent is almost always occupied by a minute shrimp-like crustacean devouring not only the fat young embryos, but the whole substance of the sponge itself (especially in captivity), the young individuals, which at this time have nothing of the kind in them to attract these animals, are left untouched.

Having then cut off a few of the branches of the *Ptilota* bearing adult specimens of *Grantia compressa*, they were placed in a glass vessel in fresh sea-water on the 12th of August, where they remained undisturbed for seven days, when they were taken out, and the residue at the bottom, after the greater part of the water had been carefully drawn off by a siphon, was placed in a flat glass vessel under an inch compound power for examination. In this residuum several specimens of the embryo in its *active* state were observed (Pl. XX. fig. 13), together with others that had become *passive*, on their way to become developed into the perfect sponge (figs. 16 & 17), and specimens of the latter also (figs. 18 & 19). These were successively taken out with the pipette, as before mentioned, and transferred to a slide for examination with a much higher compound power, viz. that of $\frac{1}{4}$-inch focus.

Of the early part of the development of the ovum I need say nothing beyond what has already been mentioned in the "First Period," viz. that it becomes attached to the surface of the excretory canal, and that in the "Second Period" it undergoes segmentation, as shown by Häckel. We shall therefore go at once to the others, viz. the Third and Fourth Periods.

Third Period.

The embryo of *Grantia compressa*, commencing almost in a globular form, still remains encapsuled in the parent until fully prepared for an independent existence, when it breaks through its capsule and leaves the parent somewhat elongated (Pl. XX. fig. 13).

It is now cylindrical, a little longer than broad, obtusely conical at one end (fig. 13, *a*), and roundly truncated at the other (fig. 13, *d*). The surface is covered with a layer of minute monociliated cells (fig. 13, *b*), which cells being much longer than they are broad, and more or less wedge-shaped, form (in juxtaposition) a crust of columnar structure, radiating perpendicularly all over the body of the embryo, except at its posterior or truncated end (fig. 13, *f*).

This layer of monociliated cells is, as before stated, only represented *generally* in the embryo of *Halisarca lobularis* (Pl. XX. fig. 11), and omitted for convenience in the rest, or rather reduced to a mere line of marginal dots. The cilia are separated at the apex (fig. 13, *c*), and, from this, slope in opposite directions, more or less backward, to the posterior end, which presents a group of large nucleated cells that are naked or unciliated (fig. 13, *d*), as in *Halichondria simulans*. Lastly, there is a brownish-yellow-coloured globular cavity in the centre (fig. 13, *e*). The embryo progresses in the direction of the apex, with the truncated end behind, and rotates from left to right, as shown by the arrows respectively on the figure of the embryo of *Halichondria simulans*, attaching itself in the same way to the bottom of the glass or foreign objects by the bunch of large cells at the posterior end, which, thus evidencing signs of being polymorphic and prehensile, I have regarded as a temporary development for rooting or fixation. At this time its total length is about 1-360th inch, with a little less transverse diameter, thus contrasting strongly, in point of size, with the embryo of *Halichondria simulans*, which, as before stated, is 1-30th inch long by 1-90th inch wide. Such is the embryo of *Grantia compressa* when it has issued naturally from the parent after the manner mentioned.

If we now compress this embryo under a glass cover, in order to examine its composition with a much higher compound power, viz. that of $\frac{1}{4}$-inch focus, we shall observe that the cavity in the centre assumes a conical truncated form (fig. 14, *a*), that the body between this and the ectodermal layer of cells is composed of sarcode charged with cells which are double the size of the latter, viz. 1-6000th inch in diameter (fig. 14, *b*), together with granules, and that the root-cells, each of which is charged with granular plasma, including a distinct nucleus and nucleolus, are again five times as large as the body-cells—that is, 5-6000ths inch in diameter (fig. 14, *c*). But as yet, although the embryo is matured and has left the parent, there is *not the least trace of spicules* (fig. 14).

Lieberkühn (Archiv f. Anat. u. Phys. 1859, p. 379, pl. ix. fig. 7), in describing and figuring this embryo with the cells above mentioned, alludes to the brown (*braune*) colouring-matter about the central cavity.

In a still more advanced state, probably, this cavity appears to become elongated and elliptical (fig. 15, *a*); and it is worthy of remark that, while the brown colouring-matter seen about the cavity in the embryo of *Grantia compressa* has the same appearance as that about the bunch of root-cells at the base of the embryo of *Halichondria simulans*, the root-cells of the embryo of *Grantia compressa* first make their appearance in this part of the embryo, and hence have been called by Häckel the "endodermal layer"—erroneously, I think, because the real endodermal mass or layer appears to consist of the sarcode charged with cells and granules which I have stated to exist between the brown-coloured cavity and the ectodermal layer (see also Lieberkühn's figure for this, *l. c.*).

Whether the root-cells in the embryo of *Halichondria simulans* make their first appearance in the centre of this body I cannot pretend to say, on account of its opaqueness at maturity and during its previous stages; but that they do so in the embryo of *Halisarca lobularis* its transparency enables one to see distinctly, as our illustration will show (Pl. XX. fig. 12, *c d*).

Fourth Period.

On account of the microscopic size of the embryo of *Grantia compressa* when it leaves the parent (Pl. XX. fig. 13), compared with that of *Halichondria simulans* (Pl. XXI. fig. 21), which may be seen with the unassisted eye, I could not treat the former in the same way as the latter to follow its development through the *first part* of this period, and therefore was obliged to have recourse to the examination of objects in the residuum mentioned, which might perchance afford these stages. This was not difficult, so far as the young *Grantia compressa* when fully developed was concerned, as there were many specimens of it in the residuum as well as on the dried pieces of *Ptilota* bearing the young and old forms together, which, only being a trifle larger than the embryos in their bodies respectively, as may be seen by the illustrations (Pl. XX. figs. 13 and 18), might be assumed to be the earliest form of the perfected sponge.

I, however, was so fortunate as to meet with two specimens where the respective stages between the fixation of the embryo and the fully developed sponge were amply represented; in one of which (fig. 16), the dermal membrane (*a*) still retained its even, round continuity, while the interior only contained *four* triradiate spicules (fig. 16, *b*) in the midst of a mass consisting of sarcode charged with cells of a uniform size, viz. about 2 6000ths inch in diameter, and granules (fig. 16, *c*), but with no appearance now of the larger "root-cells."

In the other specimen (fig. 17) the triradiate spicules were more numerous (fig. 17 *b*), and there were several of the characteristic club-shaped spicules present (fig. 20), which, having their free points in contact with the dermal (ectodermal) membrane, had forced the latter outwards so as to destroy the even continuity of its surface and thus render it monticular (fig. 17, *c c*); so that, of these two instances, we have in one (fig. 16) the retraction of the dermal cilia and the development of the first spicules *before* the latter begin to push outward the dermal membrane, and in the other (fig. 17) an increase of the triradiates with the addition of the club-shaped surface-spicules *after* the latter have begun to push out the dermal membrane —respectively analogous to similar stages of development in the embryo of *Halichondria simulans*, described under the "Fourth Period."

Here it should be added that, on crushing the latter specimen (fig. 17) for more minute examination, not only did the soft contents come out in the state of sarcode charged with cells of uniform size like the last, viz. about 2-6000ths inch in diameter (fig. 17, *d d*), but many of these cells, which were isolated, were also monociliated (fig. 17, *f*), and others appeared in an aggregated, pavimental form as fragments of the ampullaceous sacs (fig. 17, *a*), while after a short time many of the isolated cells began to put forth pseudopodia and creep about the slide after the manner of *Amœbæ* (fig. 17, *g*). But in no part was there any appearance of the root-cells, any more than in the former specimen. Thus it was evident that, at this period, the spongozoa and ampullaceous sacs, although still very soft and delicate in structure, had been developed.

Afterwards it was easy, as before mentioned, to find specimens of the fully developed young *Grantia compressa*; and, from observing that the triradiate spicules were confined to the body and the club-shaped ones to the surface in these specimens, together with the triradiates appearing first and by themselves in the previous stage mentioned, it was not unreasonable to infer that the triradiates of the body were the spicules first developed. The fully developed young *Grantia compressa* (figs. 18 & 19) now measured in the *body* (fig. 18, *a*) 7 by 4-1800ths of an inch in its greatest diameters, while that of the ciliated active embryo (fig. 13) at the time of leaving the parent measured $5\frac{1}{2}$ by 4-1800ths of an inch. Still we have to add to the former the distance of the *ends* of the club-shaped surface-spicules from the surface of the *body* (fig. 18, *c*), as the dermal membrane must have covered them when they were first developed, and have only left them naked when the sarcodal contents withdrew themselves inwards to form the purse-like body. If, then, we add this distance, it will raise the measurement of our fully developed or embryonal *Grantia* *compressa* to 12 by 8-1800ths of an inch (fig. 18); and this will bring it nearer to the size of the two specimens found in the preceding stages (figs. 16 & 17), although then the latter will appear very large. Still, that they do represent the earlier stages of this period of development in *Grantia compressa*, their composition demonstrated beyond doubt.

Hence, with the exception of following the active embryo of *Grantia compressa* to its state of fixation and the withdrawal of the cilia, which, from its microscopic minuteness, would be very difficult if possible, the whole of the development of the embryo of *Grantia compressa*, from the earliest recognizable appearance of the ovum to the fully developed sponge, has thus been described and illustrated.

Observations.

When we compare the embryo of *Grantia compressa* with that of *Halichondria simulans* at their exit from the parent respectively, we can hardly come to any other conclusion than that their development into the true form of the respective parents must follow a similar course—since, although this form may differ in these two particular sponges, it does not so generally; for there are tubular and sessile spreading forms of both calcareous and siliceous sponges, and in some instances even the same species of either may appear under both these forms.

In the first place, the shape of the embryo in the sponges just mentioned is conical, with a pointed and a truncated end; the body is covered by a layer of minute monociliated cells (the ectoderm), whose cilia slope in opposite directions from the apex, and are more or less inclined backwards towards the obtuse end, where there is a bunch of larger cells *un*covered by cilia; the embryo progresses with its pointed end foremost, and rotates from left to right; and both embryos attach themselves to the bottom of the glass vessel and foreign objects respectively by the posterior extremity or bunch of large cells, which thus appear to possess a plastic prehensile property.

On the other hand, internally, the body is composed of sarcode charged with cells (of different sizes) and granules, among which the largest of the former far exceed in size the dermal cells; while the bunch of large cells at the posterior end may be seen in the embryo of *Grantia compressa* to originate from its centre, thus having the body-substance (which appears to be the endoderm or substance in which the spicules, horny skeleton, and ampullaceous sacs are developed) *between* it and the ectodermal layer (Pl. XX. figs. 13 & 15).

Under these circumstances we cannot help concluding that the embryo of *Grantia compressa* (although this has not actually been witnessed) does attach itself, to the body (viz. the branch of *Ptilota*) on which it becomes developed, by the bunch of cells at the base of the cone, and therefore that these are especially provided for *rooting* the embryo.

Of the whole of the development of the embryo of *Grantia compressa*, this, as before stated, on account of the minuteness of the former at this period, has not been seen; but that the embryo does become fixed in this way, and that the pointed end becomes the mouth (*osculum*) or aperture of the cavity of the body in the young *Grantia compressa*, and not the obtuse unciliated end, may be reasonably concluded from the comparison between the embryos of *Grantia compressa* and that of *Halichondria simulans* just instituted.

Every thing too, after this, points to the same kind of development in the fourth period as that presented by the embryo of *Halichondria simulans* in passing into the form of the parent sponge; so that to make an exception of the mode of attachment because we have not actually seen it in *Grantia compressa* seems to me, under such circumstances, most unreasonable.

Lieberkühn, who, as before stated, described and figured this embryo in 1859 ('Archiv f. Anat. u. Phys.' p. 379, pl. ix. fig. 7), and Schmidt, who did the same in 1866 ('Spong. adriat. Meeres,' 2nd suppl. p. 5, pl. i. fig. 6), have considered the truncated, unciliated end the *hinder* portion; yet Häckel (in 1870), in opposition to these distinguished spongologists, has turned it upside down (' Die Kalkschwämme,' vol. i. pp. 336–8, Atlas, pl. xiii. figs. 5 & 6, and pl. xx. figs. 3 & 4 &c.).

Now, supposing that Häckel had not studied the development of the ovum into the perfect sponge in the siliceous species, and therefore had not the analogy to go by that we have, but had really seen the embryo of the calcareous sponges after it had left the parent in a natural way (that is, not by forced expulsion under the tearing to pieces of the body of the parent on a slide, but, by cutting off a branch of the *Ptilota* on which the sponge might be growing, and treating it in the way above mentioned), he ought to have observed that its progression was with the pointed or ciliated end (Pl. XX. fig. 13, *a*) foremost, that the cilia of the ectoderm (fig. 13, *b*) were thus more or less inclined towards the posterior or truncated unciliated end (fig. 13, *d*), and that it attached itself to the glass vessel and foreign bodies by this end; under which circumstances it seems to me that he might have at once concluded that, on becoming fixed, the bunch of large cells at the posterior end (fig. 13, *d*), being *without* cilia and endowed with a plastic nature and prehensile property, would be more likely to serve as a temporary *rooting* development than the upper or *ciliated* end, which thus appears to be at first entirely developed for locomotion, as the retraction of the cilia proves when it becomes fixed or stationary.

But with the analogy of the development of the embryo of the siliceous sponges this does not seem to admit of doubt.

If Häckel followed the development of the *embryo* of the calcareous sponges (which he terms "*gastrula*") through its transformations into the perfect sponge, he has given no illustrations of it in his work. Nothing of this kind is to be found in his 'Atlas' between the figure of the embryo (Taf. xxx. figs. 8 & 9 &c.) and the coloured diagrams (Taf. xx. figs. 3 & 4 &c.) which are intended to illustrate his theory; while his figures of the embryo of the calcareous sponges that he examined at Lesina (*op. cit.* Atlas, Taf. xxx. figs. 8 & 9 &c.) bear upon them a feature which, although it may suit Häckel's theory, is not in accordance with fact. I allude to the direction of the cilia, which are all made to flow "backwards" or *from* the obtuse or unciliated end, as if the embryo progressed with this end foremost. (Lieberkühn has done the same; but Schmidt not so, *l. c.*) I need hardly add that this is not the case (Pl. XX. figs. 13 & 15). Living cilia always lie in the opposite direction to that of the progress of the body of which they are the locomotive organs.

What position these cilia may occasionally have when the embryo is obtained by forced expulsion after the manner mentioned, I am not prepared to say, beyond the fact that, even in such immature embryos, I have never seen the cilia in the position figured by Häckel. When, therefore, I stated in the 'Annals' (1874, vol. xiv. p. 98) that "Häckel's illustrations could hardly be too highly praised" &c., I had merely studied the embryo of the calcareous sponges by scratching it out on a slide in sea-water from a *Grantia compressa* which was then pregnant with them, not having seen until lately (that is, since I have followed the development of the ovule in the siliceous sponges) the necessity of viewing it as it leaves the parent in the *natural way*. Hence my opinion of the correctness of Häckel's illustrations has undergone much modification; for, beautiful as they must be admitted to be in an artistic point of view, I cannot now help stating respecting them, that "pictures are not always proofs!"

Moreover, by accepting Häckel's views at that time, I took for the endoderm of the embryo in the calcareous sponges that which (now I have had the opportunity of following the development of the embryo in the siliceous sponges) must, I think, be regarded as a temporary production of *rooting cells* (Pl. XX. figs. 13 & 15, *d*). I allude to the bunch of large cells at the posterior extremity, which originally comes from the centre of the embryo (see that of *Halisarca lobularis*, Pl. XX. fig. 12, *d*), and has, as before stated, the real ectoderm (in which the spicules and skeleton-structure, together with the spongozoa and ampullaceous sacs, are developed) *between* it and the ectodermal layer.

That these naked plastic cells should be engaged in rooting the embryo, and not the monociliated cells of the ectodermal layer, which has for its part at the commencement the locomotion alone of the embryo, seems to me to be by far the most probable conclusion, even if we had not the fact analogically demonstrated by the development of the embryo in *Halichondria simulans*.

As regards the cavity presented by the purse or bottle-like forms of the calcareous sponges, ex. gr. *Grantia compressa*, *Grantia ciliata*, &c., called by Dr. Bowerbank the "cloaca," into which the excretory canals empty themselves, this is nothing more than the dilated extremity of the excretory canal-system modified, and as common in the tubular or hollow digital forms of the siliceous sponges as in the calcareous ones; while the more common form, in which the excretory canal-system is accompanied by no such cloacal termination, renders this structure in the calcareous sponge *Leuconia nivea* &c., identical with that of the sessile spreading form of *Halichondria simulans*.

Thus, when we consider the resemblance in form that exists between the embryo of the calcareous and that of the siliceous sponges, ex. gr. *Halichondria simulans*, and that the papilla at the end of the latter becomes the vent of its excretory canal-system, which in form is identical with the excretory canal-system of the calcareous sponge *Leuconia nivea*, and, but for its presenting the purse-like tubular modification in *Grantia compressa*, is in the latter equally identical, it is difficult to conceive that in the embryo of the calcareous sponges this system is developed in any way different from that in the embryo of the siliceous sponges.

How the excretory canal-system is produced I am not prepared to say. It may be by an inversion or extension inwards of the ectodermal layer. But whatever this may be, to reverse the embryo in the calcareous sponges for this purpose, as done by Häckel, seems to me to be utterly unsupported. I have already stated that the microscopic minuteness of the embryo of the calcareous sponges, when it issues from the parent, precludes the possibility of following it to its place of settlement previous to further development, as may be done with that of the embryo of *Halichondria simulans*, which, from its great size and opaque white colour, may be seen even with the unassisted eye. But the facts of the great resemblance between the two, and their habit of attaching themselves now and then to the bottom of the glass vessel or to foreign objects by the truncated or *un*ciliated end while in locomotion, and the latter having been actually seen to fix itself by the truncated end for further development, while the subsequent developments are the same in both cases (that is, into the respective parent structures), render it more than probable that the settling down and disappearance of the cilia, which is the *only* point in the development of the calcareous sponges that has not been observed, is also the same as that of the siliceous sponges.

Since the above was written, I have seen a short article, with illustrations, on the development of the embryo of the Calcispongiæ by E. Metschnikoff, in Siebold and Kölliker's 'Zeitschrift für wissensch. Zoologie' (Band xxiv., erstes Heft, p. 1, Taf. i., published on the 12th of February last), wherein I am pleased to find that the author has inserted what Häckel has omitted, and that my own views and figures on this subject have been anticipated, but so much more sequentially and completely given that they are of far more consequence to the student than my own. Not less so the second part of the article, which is devoted to a sharp criticism on Häckel's statements in 'Die Kalkschwämme,' and, coming from such high and practical authority as Metschnikoff, merits a confidence which even the uninspired Historian of the Creation fails to command; that is, it is *res non verba*!

From the almost identity of Metschnikoff's single figure of a "*Reniera*-Larve," obtained in the Crimea, with mine of *Halichondria simulans* =*Reniera palmata*, Sdt. (?), found here, it is just possible that both came from the same species of sponge.

Embryos of Halisarca lobularis.

Returning to *Halisarca lobularis*, there are yet two figures of the embryo of this sponge among the illustrations which, as before stated, I have purposely omitted to notice, since at the time of describing the development of the ovum in this sponge up to the ultimate degree of duplicative subdivision, or to the end of the second period of development, it was desirable not to go further.

The first of these figures (Pl. XX. fig. 11) represents the embryo at that stage in which the spheroidal ovum has become elongated into an ovoid shape, covered throughout by the ciliated ectoderm (fig. 11, *a*), whose cilia in the anterior two thirds (fig. 11, *b*) are much longer than those of the posterior one, and, although still somewhat inclined backwards, stand out from the surface in a bristly form (much like the cilia on some of the embryos of the calcareous sponges), contrasting strongly with those which cover the posterior third (fig. 11, *c*), which, on the other hand, appear much shorter, or, at all events, are much more inclined backwards, and thus lie closer together, ending in a kind of tuft a little longer than the rest, where they meet each other from opposite directions at the posterior extremity of the body (fig. 11, *d*). The embryo is now coloured red-violet, like that of the spongozoa in the parent, but most strongly over the posterior third, where the colour-margin appears to be somewhat pressed inwards laterally, and thus, by its form and deeper colour, distinctly marks this portion.

The other figure (12) represents another embryo (of which there were forty or fifty swimming about the glass in which the parent sponge was placed, for nearly a fortnight), of the same kind as the foregoing, but with a papillary eminence on the anterior extremity separating the cilia in front (fig. 12, *b*), and a group of large *un*ciliated cells projecting from behind in the midst of the "tuft" of longer cilia just mentioned (fig. 12, *c*). By lowering the focus, these cells were observed to be part of a group filling the centre of the embryo (fig. 12, *d*), after the manner of those presented by the earlier stages of the embryo of the calcareous sponges, and indicating in the same way the existence of a body-substance between them and the ectodermal layer. Like the embryos of the other sponges, these swim with the pointed end foremost and present a rotatory motion from left to right, indicating, as before stated, that the cilia are arranged over the body in a spiral direction. Of course such cilia always lie, as before stated, in the opposite direction to the progress of the body of which they are the locomotive organs—that is, backwards.

All the embryos had left the parent naturally, and averaged in size about 16 by 10-1800ths inch in their greatest diameters, or about 1-112th inch long—therefore much smaller than the embryo of *Halichondria simulans*, and much larger than that of *Grantia compressa*. The most remarkable feature about them is their deep red-violet colour; and although they remained alive and active for several days, as before stated, and I placed objects in the glass vessel for them to become fixed upon, this was not successful even in a single instance; hence I had not the opportunity of following their further development as in *Halichondria simulans*.

Comparison of the Development of the Sponge developed from the embryo of Halichondria simulans *with that of* Spongilla *developed from the seed-like body.*

On comparing the development of the sponge from the embryo of *Halichondria simulans* after it has become stationary or fixed (viz. the Fourth Period) with that developed from the seed-like body of *Spongilla*, one cannot help being struck with the facts that the appearance of the latter at first in an opaque unciliated mass, as it issues from the hiliform opening of the seed-like body, followed by the extension of a homogeneous-looking sarcode, denticulated at the margin like the pseudopodia of an *Amœba*, then the projection from this substance of spicules which thus raise and angulate the previously round surface, afterwards the shrinking inwards of the opaque or parenchymatous portion while the dermal layer is still left upon the points of the spicules in the form of the "investing membrane" and its "cavity" (the intermarginal cavity of Bowerbank) beneath, together with the exit from the seed-like body of its transparent spherical germiniferous cells *entire* and their subsequent appearance in the general mass as ampullaceous sacs ('Annals,' 1849 & 1857 respectively, *locc. citt.*), are all identical with what we have observed in the development of the embryo of *Halichondria simulans* during the Fourth Period. But here the identification ends, inasmuch as there are no spicules already formed in the seed-like body as there are in the embryo of *Halichondria simulans* even before the latter leaves the parent, while the contents of this body chiefly consist of the transparent spherical cells, which already contain the cell-germs of the spongozoa, preparatory to their passing into the form of the ampullaceous sac the moment they get into the general mass which grows out from the hiliform opening of the seed-like body; so that, in fact, while the spicules are already developed at a very early period in the embryo of *Halichondria simulans*, and the groups of spongozoa, which finally form the ampullaceous sacs, do not appear before the sponge is fully developed, the reverse is the case with the sponge-substance which issues from the seed-like body of *Spongilla*, where at first there are no spicules present, but the ampullaceous sacs are already foreshadowed by the transparent spherical germiniferous cells, each of which measures at this time 1-800th inch in diameter.

Now it so happens that in the embryo of *Halichondria simulans* there are many cells in the body-substance about 1-3000th inch in diameter, which, being evidently filled with cellulæ (Pl. XXI. figs. 21, *c*, & 22, *c*), I have before suggested might be the early forms of the ampullaceous sacs; and if this be the case, then these sacs are also here foreshadowed, which would account for their great number and full development in the perfected sponge into which the embryo of the species ultimately passes.

Again, should this be right, and we have thus, in the embryo of *Halichondria simulans*, something analogous to the transparent cells in the seed-like body of *Spongilla*, we shall have to regard the latter as a single ovum, modified in form to meet the circumstances of the case (that is, for preserving the germinative or reproductive substance by a horn-like covering during the dry weather); whereas the "swarm-spore" of *Spongilla*, first described and figured by Lieberkühn ('Archiv f. Anat. u. Phys.' 1856, pl. xv. fig. 35), being like the soft ciliated embryo of *Halichondria simulans*, would be for immediate reproduction.

On referring to the sizes of the seed-like bodies in my description of the five species of freshwater sponges in the island of Bombay ('Annals,' 1849, vol. iv. p. 1), I observe that the diameter of the largest spheroidal form is the same as the long diameter of the embryo of *Halichondria simulans*, viz. about 1-30th of an inch, while that of the other species is much smaller, and that of *Spongilla plumosa*, whose seed-like body is elliptical, is, in its largest diameter, 1-22nd part of an inch. Again, the embryos of the marine sponges *Tethya cranium* and *Tethya zetlandica*, which I described and figured (*loc. cit.* pl. xxii. figs. 4 & 10), were, before leaving the parent, respectively 1-24th and 1-16th of an inch in diameter.

If, then, the contents of the embryo of *Halichondria simulans* can contain and develop a great number of ampullaceous sacs *at once*, we do not wonder that the seed-like body of *Spongilla* should contain a great number of transparent spherical germiniferous cells which also *at once* pass into the young *Spongilla* and become ampullaceous sacs—only that they are in the latter developed in advance of the spicules, while in the former the spicules are developed in advance of them.

Thus, then, my conclusion respecting the "real import" of the seed-like body of *Spongilla*, at the end of my observations on the subject ('Annals,' 1874, vol. xiv. p. 100)—viz. that it was tantamount to an ovary of which each transparent spherical germiniferous cell was equal to an ovum, and thus immediately passed into an ampullaceous sac as the new sponge-substance issued from the seed-like body in the form of the young *Spongilla*—becomes untenable, as well as the conclusion that "Häckel's gastrula developed *in situ*" was only equal to one of these ampullaceous sacs.

I must therefore fall back upon the term "ovum" for the seed-like body of *Spongilla*, as it was called in my paper "On the Identity in Structure and Composition of the so-called Seed-like Body of *Spongilla* with the Winter-egg of the Bryozoa" ('Annals,' 1859, vol. iii. p. 331, pl. viii.), as first suggested by Meyen (Microscop. Journ. vol. i. p. 42, *ap.* Johnston, footnote p. 154, B. S. 1842), and view it now again as a *simple* ovum with modified form to meet the requirements of the case—thus equal, as a whole and after this manner *only*, to the "gastrula" of Häckel—that is, our embryo of *Grantia compressa.*

Lastly, it becomes a matter for consideration what the nature of the perfectly developed sponge is—if, in the end, the single ovum comes out with a great number of ampullaceous sacs, composed of a still greater number of spongozoa. And this brings us back to the point from which we started, viz. where we found the earliest appearance of the ovum but a little larger than a single spongozoon (Pl. XX. figs. 2, *a*, & 3, *a*). Thence the question whether this ovum was previously put forth singly, as the product of a single spongozoon, or in plurality, as the product of its ovary—and, finally, the question whether the whole of the perfected sponge has not been evolved from an ovule probably much smaller, in the first instance, than the spongozoon itself. If so, then the spongozoon (Pl. XX. fig. 2, *a*). must, *ipso facto*, be considered the expression of the Sponge, in so far that it represents the stomach and the generative apparatus aided by the rest of the body, which thus becomes analogous to such accessories in the highest animals, although the *plurality* of spongozoa scattered through the mass may more nearly resemble in this respect the flower-buds of a plant. Such, then, appears to be the nature of a sponge.

Not only do the seed-like bodies of *Spongilla* vary in size in the different species, but, as may be seen by my illustrations, this is strikingly the case with the embryos respectively of *Halisarca lobularis*, *Grantia compressa*, and *Halichondria simulans* among the marine sponges, while the size of the embryo itself also differs greatly in the same individual. Lastly, the constitution of the embryo, its colour, and ultimate development also differ in different species; so that here, as well as everywhere else in connexion with the sponges, their protean character is sustained by varieties and peculiarities which must necessitate the examination of every species from the ovule to the parent before we can hope for a satisfactory generalization.

Having now premised the development of the sponge—which, but for the pecuniary aid (from the Government grant) kindly given to me by the Royal Society, I should never have accomplished)—I hope to put forth that classification of the sponges generally which has chiefly resulted from my examination and arrangement of the collection in the British Museum.

EXPLANATION OF THE PLATES.

N.B. All the figures in Plates XX. and XXI., with the exception of the first and a little minor detail in figs. 14 & 17 which will be otherwise mentioned, are drawn, as near as possible, to the scale of 1-12th to 1-1800th of an inch, in order that their relative sizes may be at once appreciated.

The first figure, although drawn to a much smaller scale, viz. 1-48th to 1-1800th of an inch, has its detail also drawn to this scale.

Plate XX.

Fig. 1. *Halisarca lobularis*, Schmidt, vertical section (diagrammatic) of an oviparous portion, with detail relatively magnified to the scale of 1-48th to 1-1800th of an inch or thereabouts: *a a*, sponge reduced to a thin layer, covering a heap of ova in different stages of development; *b b*, ova; *c c*, surface of the rock on which they rest; *d*, ampullaceous sacs, or groups of spongozoa, of a red-violet colour; *e e*, layer of cilia on the surface of the sponge; *f*, osculum or vent, provided with a sphinctral diaphragm of sarcode; *g*, sac-like membrane common to the heap of ova, opening (?) at the vent; *h h h*, spheroidal ova in different stages of development, showing the segmentation of the yelk; *i*, elliptical embryo, whose ciliated ectoderm is marked by the dotted line; *k*, its capsule.

N.B. Each ovum, although spheroidal, and, for convenience, represented without capsule, has nevertheless its proper one, and gradually passes from this form into the elliptical one of the embryo.

Fig. 2. The same, vertical section of the ampullaceous sac, showing the position of the pavement-layer of spongozoa: *a*, separate spongozoon. Scale 1-12th to 1-1800th of an inch.

Fig. 3. The same, ova at an early period: *a*, ovum when first recognizable, in a passive or spheroidal form, 1-3000th of an inch in diameter; *b*, ovum when further advanced, viz. 6-6000ths inch in diameter, showing distinctly the yelk, nucleus, nucleolus, and germinal vesicle, together with the polymorphic locomotive envelope *c*.

Fig. 4. The same, ovum in which the yelk has undergone the first duplicative division, now 31-6000ths of an inch in diameter: *a*, capsule; *b*, membrane of the yelk; *c*, line dividing the yelk into two equal parts or cells; *d d*, nuclei.

Figs. 5, 6, 7, 8, 9, & 10. The same, showing the second, third, fourth, fifth, sixth, and seventh degrees of duplicative subdivision in the ovnm respectively. The nuclei are omitted in all of these for reasons mentioned in the text.

Fig. 11. The same, embryo: *a*, ectodermal layer, represented by the dots over the surface of the body; *b*, long cilia; *c*, short cilia; *d*, tuft at posterior extremity.

N.B. After this the monociliated cells which compose the ectoderm will be *only* represented by the dotted line at the margin of the embryo.

Fig. 12. The same, embryo more advanced: *a*, ectodermal layer; *b*, papillary projection at the anterior extremity; *c*, group of root-cells at the posterior extremity, produced from *d*, the same kind of cells in the centre of the embryo.

Fig. 13. *Grantia compressa*, embryo as it issues from the parent. Assumed vertical section, showing: *a*, the conical form of its body; *b*, monociliated ectoderm; *c*, opposite direction of the cilia at the apex; *d*, group of root-cells at the posterior extremity; *e*, central cavity; *f*, line indicating the inner boundary of the crust of monociliated cells on the surface, or ectoderm.

Fig. 14. The same, embryo under pressure of a glass-cover, showing the same as the foregoing, but with :—*a*, a conical truncated form of the central cavity; *b*, specimen of cells and granules of the body between the central cavity and the ectoderm, magnified on a larger scale, viz. 1-24th to 1-6000th of an inch; and *c*, specimen of the root-cell on the same scale, showing the nucleus and nucleolus.

Fig. 15. The same, embryo slightly more advanced (?). Assumed vertical section, showing the same as fig. 12, but with the central cavity (*a*) larger and elliptical in shape.

Fig. 16. The same, embryo at the commencement of the Fourth Period of development, after it has become fixed, the cilia withdrawn, and a few of the triradiate spicules have been formed: *a*, dermal membrane or ectoderm; *b*, triradiate spicules; *c*, sarcode charged with cells and granules, filling the interior.

Fig. 17. The same, embryo more advanced, where the triradiate spicules have increased in number and the club-shaped surface-spicules have begun to appear and push outward the dermal membrane: *a*, dermal membrane or ectoderm; *b*, triradiate spicules; *c c*, club-shaped surface-spicules; *d d*, sarcode charged with cells and granules; *e*, specimen of the "cells" of the body on a larger scale, showing that they are spongozoa, and come from fragments of the ampullaceous sacs; *f*, monociliated spongozoon; *g*, spongozoa putting forth pseudopodial processes.

Fig. 18. Young individual of *Grantia compressa* only a little larger than the embryo from which it has been developed: *a*, body; *b*, triradiate spicules; *c*, club-shaped surface-spicules.

Fig. 19. Young individual of *Grantia compressa* taken from a branch of *Ptilota sericea*, on which old and young specimens abounded: *a*, *b*, *c*, the same as before; *d*, foreign body to which it is attached.

Fig. 20. Magnified view of the club-shaped or characteristic form of surface-spicule of the same, to show its form in figs. 18 & 19.

Plate XXI.

Fig. 21. *Halichondria simulans*, Johnston, active locomotive embryo on issuing from the parent naturally: *a*, body; *b*, spicules, cells, and granules with which the sarcode of the body is charged; *c*, cells with cellulæ in their interior, either undergoing endogenous cell-formation or foreshadowing the ampullaceous sacs; *d*, monociliated layer of ectodermal cells; *e*, papillary projection at the anterior extremity of the body not covered with cilia; *f*, root-cells forming a brownish-yellow ring round the truncated or posterior end, also not covered with cilia; *g*, ring of large long cilia along the line of demarcation between the root-cells and the body; *h*, arrow showing the direction in which the embryo swims; *i*, arrow showing the direction in which the body rotates.

N.B. The arrows in this figure also represent the directions of progress and rotation respectively in the embryos of *Halisarca lobularis* and *Grantia compressa.*

***Fig.* 22.** The same, active locomotive embryo a day or two after issuing from the parent, showing the shortening and widening which take place previous to its becoming stationary; also the more general form of the brownish-yellow mass of root-cells (*a*), and an eccentric position of the papilla at the apex (*b*). Other detail the same as in the foregoing figure.

***Fig.* 23.** The same, vertical section of the ampullaceous sac of adult, showing its globular form and the position of its pavimental lining of monociliated spongozoa: *a*, separate spongozoon.

***Fig.* 24.** The same, specimen of the spicule of adult.

***Fig.* 25.** *Esperia ægagropila*, Cart. (variety, see p. 333. *Loc.* Budleigh-Salterton), spheroidal form of embryo, obtained by forcible expulsion from the parent, showing that it is encapsuled, ciliated, and composed internally of sarcode charged with cells of different sizes, granules, and *all* the forms of spicules peculiar to the species: *a*, cells bearing cellulæ; *b*, skeleton-spicules; *c*, *d*, *e*, forms of flesh-spicules respectively, viz. anchorate, bihamate, and tricurvate; *f*, monociliated layer of the surface or ectoderm; *g*, capsule.

***Fig.* 26.** The same, tricurvate spicule from the substance of the adult, showing its linear, almost straight form, and entire enclosure in a mother cell: *a*, spicule; *b*, mother cell; *c*, nucleus of cell.

***Fig.* 27.** *Microciona armata*, Bk.(?) (see description p. 457), tricurvate spicule, curved suddenly in the centre, elongated at the ends which are spined: *a*, spicule; *b*, mother cell; *c*, nucleus; *d*, more magnified view of spined extremity.

Plate XXII.

N.B. All the figures in this Plate, with the exception of the last, are drawn to the scale of 1-12th to 1-830th of an inch—that is, to a scale a little less than half the size of the foregoing.

***Fig.* 28.** *Halichondria simulans*, embryo at the commencement of the fourth period of development, showing that it has become fixed and attached by the posterior extremity to the surface of the pebble; the body somewhat contracted, and the cilia of the ectodermal cells withdrawn, while those forming a ring round the base are still moving languidly: *a*, body; *b*, papillary eminence at the apex; *c*, ring of large cilia and expanded base (the latter formed by the root-cells?); *d*, surface of pebble; *e*, position of the spicules in the embryo.

***Fig.* 29.** The same, more advanced stage, showing the expansion of the ectoderm laterally into a kind of denticulated foot (*a a*), and the opaque body (*b*) in the centre erect and conical, with the papilla, now become a depression, at the apex (*c*). Lateral view.

***Fig.* 30.** The same, still more advanced stage, showing that the smooth surface has become monticular or angulated (*a*), and the aperture of the vent or osculum more prominent and excavated (*b*). Upper view.

***Fig.* 31.** The same, embryo, lateral view, but with the foot a little retracted.

Fig. 32. The same, more advanced stage, showing that the opaque portion or body has withdrawn itself within the dermal membrane or ectoderm, leaving the latter suspended on spicules, which project in bundles from the former, and thus producing the angulated surface first seen in fig. 30, now extend nakedly a little beyond it, leaving a cavity or open interval between it and the opaque body: *a a*, opaque portion or body; *b b*, bundles of spicules; *c c*, dermal membrane or ectoderm; *d d*, its cavity.

Compare this and the following figures with my illustrations to the paper "On the Ultimate Structure of *Spongilla*" ('Annals,' 1857, vol. xx. p. 21, plate i.), in which it will be seen that this dermal membrane is my "investing membrane," and the interval between it and the opaque body its "cavity," in *Spongilla*, also that the pores are situated in the former.

Fig. 33. The same, lateral view: *a*, vent, osculum, or termination of the end of the excretory branched canal-system, now fully developed.

Fig. 34. The same, embryo torn to pieces in sea-water on a glass slide, and placed under ¼-inch compound power; showing that the skeleton-structure, now consisting of the spicules bundled together and held in position by cornified sarcode, is fully developed into the form of that of the parent, the dermal membrane or sarcode, and also the spongozoa and ampullaceous sacs: *a a*, skeleton-structure; *b b*, sarcode of the opaque or parenchymatous body charged with fully developed ampullaceous sacs, separate spongozoa, cells of different sizes below these, and granules; *c c*, ampullaceous sacs; *d*, spongozoon separate; *e e*, dermal or "investing" membrane; *f f*, its cavity; *g*, more magnified view of monociliated spongozoa.

LI.—*Description of a new* Helix *from Southern India.* By W. T. Blanford, F.R.S.

An immature specimen of a very fine species of snail allied to *Hemiplecta basileus* (Bs.) was sent to me some years since by Colonel Beddome, to whom we owe so many discoveries amongst the numerous and peculiar molluscan forms inhabiting the forests of the Southern Indian hill-ranges. I named the species after the discoverer, but on further examination resolved not to describe it, as the characters taken from the young shell approached so closely to those of *H. basileus* and *H. Chenui* that there must have been difficulty in recognizing it. Recently Colonel Beddome has shown me a full-grown specimen, which he has presented to the British Museum; and from this I have taken the following description:—

Hemiplecta Beddomei, sp. n.

H. testa aperte perforata, convexo-depressa, tenuiuscula, oblique striata lineisque impressis spiralibus decussata, sulcis brevibus obliquis subspiralibus rugata; subtus læviore, nitidula, striis radi-